An Adaptive Image Enhancement Technique by Combining Cuckoo Search and Particle Swarm Optimization Algorithm and RWT

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Abstract
In this paper a new approach for enhancement of satellite image, which is based on AHE-RWT with SVD and PSO-CS algorithm for quality improvement of the low brightness satellite images. The satellite image is corrupted due to noise, so removing of noise is necessary from the images for better visualization. The input image is first applied for enhancement by using Adaptive Histogram Equalization (AHE) and the image is decomposed into the four sub band through the redundant wavelet transform (RWT). Optimization of each sub band of RWT is done by using cuckoo search algorithm and LL threshold sub band of the image is obtained by using singular value decomposition, finally enhanced image is reconstructed by applying inverse redundant wavelet transform (IRWT). The Particular gray scale information of the satellite image is employed by singular value decomposition (SVD). The result of proposed method is shown in terms of resolution, and mean deviation over state of the art and conventional techniques.

Keywords: Adaptive histogram equalization (AHE), Redundant wavelet transforms (RWT), PSO-CS algorithm, Singular value decomposition (SVD), and Wavelet thresholding.

1. Introduction
The enhancement is method used to make the pictures clearer. Satellite picture is contains photo of the entire or part of the earth which is taken by simulated satellite. So pictures caught by the satellite and remotely detected satellite pictures are have applications in different field, for example, geography, ranger service, agriculture, insight ,fighting and so on [1]. The satellite pictures are broadly utilized for parameter investigation and to comprehend the earth environment proficiently. Be that as it may, some satellite pictures will be in various ranges and in noticeable hues. When all is said in done, we can say crude satellite pictures are generally low scope of differentiation; henceforth contrast improvement is utilized for better show of pictures for good perception and translation.

There have been created a few procedures to beat these issues, for example, adaptive histogram equalization and general histogram equalization systems. When all is said in done, because of lacking illumination of the satellite pictures contain low element force estimation of district. So satellite pictures should be better show by preparing them. There are numerous techniques have been redesigned to improvement of force level satellite pictures this handled under spatial area. This sort of system consider general histogram equalization, high pass channel, low pass channel, gamma remedy, and so on. In some condition, DCT is a one kind of space which gives partition of ghostly and which has property with practicality to upgrade the elements by considering the particular quality recurrence segments in various structure. Be that as it may, these sorts of strategy have some drawbacks in changing the satellite pictures utilizing DCT piece [2].

In this manner, AHE is exceptionally powerful technique for low complexity upgrade of satellite pictures, so information sets are gathered from blood vessel satellite are polluted by noise. There are different sorts of noises, for example, white Gaussian commotion, dot noise, speckle noise(multiplicative noise) and in various pictures antiques modalities will degenerate the pictures, furthermore there are numerous degradations, for example, blemished instruments, issues connected with the information procurement working. Because of these sorts of corruption it will influences on human translation from the satellite pictures. Because of low quality picture the estimations of quantitative and PC helped investigation get to be issue. In this way, picture improvement gets to be vital in numerous applications, the noise expulsion from pictures still a test to the analysts.

The two areas which are extensively partitioned by picture upgrade exploration are: wavelet domain and spatial domain. From these domains in most recent three decades, numerous trials are led from wavelet transform domain. The wavelet transform domain is extremely powerful procedure for picture preparing and valuable for improvement of picture. The wavelet transform domain has characteristics coefficients such as decays and
sparsity; compelling, rearranged and effective. So the work in this technique is done by using AHE for partial enhancement and RWT is used to generate coefficients for enhancement of image through PSO-CS algorithm.

The paper is organized as follows. Section 2 is gives the brief overview of the methodologies related to the work, section 3 gives the proposed architecture work; section 4 gives the simulation result of proposed work, section 5 conclude the paper.

2. Related Work

2.1 Adaptive Histogram Equalization

Various kinds of image enhancement schemes are established to extract the gray scale manipulation. The adaptive histogram equalization is most popular method for contrast enhancement because: the AHE technique is most effective and simple [2]. Input image is contaminated by various kinds of noises. And which will affects in interpretation and visualization. So the noise is required to be removed from the image.

In order to remove the noise and for processing AHE, the input image must first convert one form of color space into another form. In AHE method, the input is in form of RGB color space will be converted into YCbCr color space: because YCbCr color space has only two axes, those are luminance and chromaticity: Y is intensity component and Cb, Cr are difference chromaticity component of blue and red color respectively. From these two axes we can easily enhance the intensity value of the image. Once we convert the color space, first we need to separate both luminance and chromaticity axes, from that we are considering only intensity (luminance) axes. After separating the axes, the intensity information will be equally distributed in window.

The AHE technique is used to increase the brightness of the satellite image, and method which computes the several histograms, each histograms of the AHE is correspond to the distinct pixel of the image and uses those values to redistribute the intensity value of the image [3]. Hence, AHE is applicable for improvement of the low brightness satellite images and enhancing the definition of the edge.

2.2 Redundant Wavelet Transform

Redundant Wavelet Transform is effective tool for image processing. Compare to Fourier transform the RWT is much flexible and has few computational loads [9]. This method constructs the better resolution image by processing all the low quality images with the reference input image. The RWT combines wavelet and interpolation with filter coefficients. The main difference between the DWT and RWT is that, DWT uses decimator factor in its operation and RWT uses interpolation in its operation. In this method decimators are omitted in the wavelet decomposition and for every decomposition level length of coefficient of wavelet kept same. It is shift invariance at expense of the more storage and computation [6]. In the data analysis all resolution levels distributed equally at same time. RWT works on simple basic idea, in this technique we just apply input to an appropriate low pass and high pass filter, in which data at each level is generate from one sequence to next level. Here up sample the sequence of the filter by factor two at every time.

The original data is on top line will be decomposed in three levels. In this method two filters are used to generate sub band frequency, from these bands the different coefficients are used for tuning purpose. It splits the input image into four frequency sub band of the image: the four sub bands are LL, LH, HL, and HH bands. The information value contained in the LL sub band has good resolution than the other bands. The interpolation with factor 2 is used to construct the frequency sub band from the image. The interpolation is Estimating process of continuous value function from the discrete samples.

The applications of the RWT method found in addressing of the high resolution problem in ordered to revalue the detailed information which is hidden by noise in the image, and RWT applications have found in image acquisition processing. And other applications of RWT with interpolation are: the interpolation is magnification of image, registration of sub pixel value image, and spatial distortion are corrected.

2.3 CS-PSO Algorithm

The PSO has advantages such as easy understanding, simple operation, and rapid searching. However, in solving a large complex problem, PSO becomes easily trapped in local optimum. This weakness must be overcome to extend the practicability of PSO. CS has advantages such as few control parameters and high efficiency, but it also has some defects, such as slow convergence speed and low accuracy. In CS, high randomness of the Lévy flight makes the search process quickly jump from one area to another area. Thus, the global search ability of the algorithm is very strong. However, given the high randomness of the Lévy flight, the algorithm initiates a blind search process, convergence speed becomes slow, and the searching efficiency is significantly reduced close to the optimal solution.

To improve the performance of CS, PSO is introduced in the update process of CS. Thus, a PSOCS hybrid algorithm is developed. PSO-CS first uses Lévy flights in the search space to search, and then it uses the position of the PSO update mode to accelerate the particles to the optimal solution convergence. At the same time, the random elimination mechanism of CS can successfully escape local optima, thereby improving the performance of searching for the optimal solution.

3. Proposed Methodology

3.1 Proposed Mechanism

In general, image enhancement is done on spatial domain by using a transformation function which produces a new intensity for each pixel of the original image to generate the enhanced image. If the spatial relationship of pixel values is changed, the enhanced image will be altered along with it. As the image size increases, the time complexity of the
algorithm will increase hugely. Incomplete Beta function enhancement method based on PSO is applied to aerial and satellite remote sensing image enhancement. The incomplete Beta function is defined as follows:

\[ F(u) = B^{-1}(\alpha, \beta) * \int_0^u t^{\alpha-1} (1-t)^{\beta-1} dt \]  
(1)

\[ B(\alpha, \beta) = \int_0^1 t^{\alpha-1} (1-t)^{\beta-1} dt \]  
(2)

In (1) and (2), \( B(\alpha, \beta) \) is the Beta function, \( t \) is the variable of integration, \( u \) is the grey-levels after normalization of the original image, and two parameters are introduced in the incomplete Beta function, namely, \( \alpha \) and \( \beta \) are to obtain as large fitness value as possible in the enhanced image. Histogram reflects a discrete probability density function about grey-levels and reports the relative frequency distribution of grey-levels. Hence, in the paper a novel objective function is proposed as

\[ F(L) = \log \left( \frac{\sum_{u=1}^U \left[ u \cdot F(I_u) \right]^{\alpha} \cdot \left[ U-u \cdot F(I_{u+1}) \right]^{\beta}} {\sum_{u=1}^U \left[ u \cdot F(I_u) \right] \cdot \left[ U-u \cdot F(I_{u+1}) \right]} \right) \]  
(3)

CS-PSO utilizes PSO algorithm as a disturbance, substitute for the process of updating the worse nests in CS algorithm. \( p_{\text{best}} \) and \( g_{\text{best}} \) enable the PSO algorithm to effectively develop the local solutions into global optimum solutions. The disturbance has nothing to do with the worse nests, which makes a broader hunting and rapidly converges to the optimal solution.

\[ v_{i+1} = W \cdot v_i + c_1 r_1 (p_{\text{best}_i} - x_i) + c_2 r_2 (g_{\text{best}_i} - x_i) \]  
(4)

\[ x_{i+1} = x_i + v_{i+1} \]  
(5)

\[ x_{i+1} = x_i + a \Theta \text{Levy}(\lambda) \]  
(6)

In order to obtain the enhanced image, a transformation function defined in (1) is used. The function contains two parameters, namely, \( \alpha \) and \( \beta \) exert a considerable influence on the performance of image enhancement. The main idea of applying CS-PSO to search the best parameters pair \( (\alpha, \beta) \) is as follows.

Each position vector of the CS-PSO stands for a candidate parameters pair for \( \alpha \) and \( \beta \). The initial population is generated with \( N \) number of solutions randomly within their range and corresponding random velocities and each solution is a \( D \)-dimension vector, here \( D \) is set as 2 that each solution represents 2D candidate parameters. \( X_i \) represents the \( i \)th bird in the population which denotes a candidate parameter pair and its fitness can be measured by fitness function defined in (3). After calculating all of the fitness values, \( p_{\text{best}} \) and \( g_{\text{best}} \) can be obtained. In CS each individual is generated by the equation defined in (6). Then, in PSO each particle is disturbed to the direction of best solution as it is reflected in (4) and (5). With the defined movement rules, the algorithm will run until it terminates and outputs the best position as the optimal parameters for \( \alpha \) and \( \beta \).

The improved technique which is based on the PSO-CS algorithm, for enhancement of brightness and contrast of the satellite images is developed. The fig. 1 shows the block diagram of the proposed system. The AHE-RWT based with particle swarm optimization and cuckoo search algorithm is employed. The enhancement is need for the satellite images because the presence of uncertainty, affected image due to some factor like environment conditions, low resolution, and low illumination and poor spatial resolution. Therefore efficient enhancement has been introduced in the work.

![Figure 1 Block diagram of proposed method](image)

The proposed methodology for image enhancement is taken in two steps. The first one is AHE which is mentioned in section 2. And it contains expanded value information of the image. The low contrast satellite image, such as in the case of LANDSAT image having 7 band data which is applied to AHE and in other way the same input image is applied to RWT block. The AHE is basic enhancement technique which increase the pixel value distribution of the input image, by this we can increase perceptional information of the satellite image. The enhanced image is converted into coefficients by using RWT technique, these coefficients are tuned for particular value from PSO-CS algorithm.

The wavelet coefficients created and which are modified through the threshold tuning function. In this type of thresholding functions flexibility will not exhibits because which has no fixed structure and dependency on threshold value is fixed. To overcome these drawback, there have been several set of thresholding values are created.

In this work, the energy level information of the satellite image has bands such as red, green and blue on which RWT is applied to get clearer image. The RWT scheme shifts the input image into four sub bands, as LL, LH, HL, and HH. The input image contains frequency components which covered in these four sub bands. Therefore after taking IRWT we will get enhanced image with good contrast and sharper. Original image is reconstructed by using IRWT to generate the resultant enhanced satellite image.
4. Simulation Result

The superiority of the proposed technique is demonstrated through MATLAB simulation running on Microsoft Window XP, Intel Core2 Duo CPU, 3 GHz platform.

![Fig. 2](image)

**(a) low quality satellite image, (b) converted color space image from AHE, (c) y plane image, (d) enhanced y plane image, (e) AHE image in YCbCr plane, (f) enhanced image.**

The fig. 2, shows how the low brightness satellite is processed for the enhancement and by the result we can observe that image is getting enhanced by applying different methods.

5. Conclusion

The two strong strategies PSO-CS algorithm and AHE-RWT are consolidated to accomplish the best upgrade for satellite picture in this paper. This paper gives a novel for the shine upgrade for low-quality satellite picture utilizing the AHE-RWT and PSO-CS algorithm. The solitary worth decay gives the dim level data for the given picture. The proposed technique changes over information picture into AHE-RWT coefficients and these coefficients are standardized utilizing particular quality decay. The information pictures is improved and recreated by utilizing IRWT. The proposed algorithm has been checked with numerous satellite pictures. The algorithm is helpful for some satellite pictures those are having low determination. The proposed algorithm is uncovers with upgrade result which is outwardly analyzed. AHE-RWT and PSO-CS is proposed.

References
